

AD-A189 267

STUDIES TOWARD OBSERVING AND MODELLING LARGE ENERGETIC  
OCEAN REGIONS(U) MASSACHUSETTS INST OF TECH CAMBRIDGE  
DEPT OF EARTH ATMOSPHERI.. C MUNSCH 02 NOV 87

1/1

UNCLASSIFIED

N00014-85-G-0241

F/G 8/3

NL





DTIC FILE COPY

SECURITY CLASSIFICATION OF THIS PAGE

## INFORMATION PAGE

1a. REPORT SECURITY CLASSIFICATION  
Unclass

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION

AD-A189 267

3. DISTRIBUTION/AVAILABILITY OF REPORT

Approved for public release; distribution unlimited

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE

4. PERFORMING ORGANIZATION REPORT NUMBER(S)

None

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION  
MIT, Dept. of Earth, Atmospheric & Planetary Sciences6b. OFFICE SYMBOL  
(If applicable)7a. NAME OF MONITORING ORGANIZATION  
Same as 6a

6c. ADDRESS (City, State, and ZIP Code)

77 Massachusetts Avenue  
Cambridge, MA 02139

7b. ADDRESS (City, State, and ZIP Code)

8a. NAME OF FUNDING/SPONSORING ORGANIZATION

Office of Naval Research

8b. OFFICE SYMBOL  
(If applicable)

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

N00014-85-G-0241

8c. ADDRESS (City, State, and ZIP Code)

Arlington, VA 22217

10. SOURCE OF FUNDING NUMBERS

PROGRAM  
ELEMENT NO.PROJECT  
NO.TASK  
NO.WORK UNIT  
ACCESSION NO.

11. TITLE (Include Security Classification)

Annual Report - Studies toward observing and modelling large energetic ocean regions.

12. PERSONAL AUTHOR(S)

Carl Wunsch

13a. TYPE OF REPORT  
annual technical13b. TIME COVERED  
FROM 10/1/86 TO 9/30/8714. DATE OF REPORT (Year, Month, Day)  
November 2, 198715. PAGE COUNT  
3

16. SUPPLEMENTARY NOTATION

Submitted in fulfillment of "Performance Reports" requirement of grant

17. COSATI CODES

FIELD GROUP SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

Physical oceanography; acoustic tomography;  
satellite altimetry; Gulf Stream, A-

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report describes progress on research on a Secretary of the Navy Research Professor grant. Studies have been made directed at: modelling high energy, near Gulf Stream regions; optimally combining data with general models, including inverse and control methods; reducing satellite data (altimetry and scatterometry) for combination into the models; and developing a new generation of operational tomographic instruments. Request 1

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT

☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION

Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL

22b. TELEPHONE (Include Area Code)

22c. OFFICE SYMBOL

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted  
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

U.S. Government Printing Office: 1985-507-047

DTIC  
ELECTE  
NOV 25 1987  
E

Progress Report on N00014-86-G-0241, "Studies Toward Observing and Modelling Large Scale Energetic Oceanic Regions", Year 2.

Under this Secretary of the Navy Chair, we have continued a diverse set of activities begun last year, focussed on the Gulf Stream system, and techniques for relating ocean data to ocean models in energetic regions. The work is collaborative amongst Profs. Malanotte-Rizzoli, Young, Flierl, and the chair holder, Prof. Wunsch.

Prof. Rizzoli with Dr. Roberta Young have studied thoroughly the sensitivity of a primitive equation model of the Gulf Stream system to data initialization and assimilation schemes. A grossly unbalanced initialization is required to induce model misbehavior. Simple balanced initializations are sufficient to avoid excitation of gravity waves and to insure smooth jet evolution. Surface pressure data only are insufficient to improve estimates of the deep circulation: it is necessary to project surface information onto the baroclinic modes or deep layers by assimilation techniques, or direct measurements.

In another theoretical study related to the Gulf Stream, Prof. Flierl and Dr. Steve Meacham have been studying weakly nonlinear disturbances to barotropic shear layers, and jets composed of one or two bands of uniform potential vorticity on a beta-plane. The amplitude equation for the nonlinear disturbances was found by using what is known as "contour dynamics". The solutions depended on the assumptions made about the dynamics FAR from the jet. Small amplitude, steady solutions, at linearly unstable wavenumbers were found near the long wave limit of instability, but not near the short wave limit. This result was used to account for the equilibration of moderately long wave disturbances to a barotropic jet obtained by Flierl, Stern and Zabusky (1986). The conditions under which long packets of neutral waves would exhibit modulational instability were also determined.

S. Sakai, working with Prof. Young, has studied the ageostrophic version of Phillips' two layer model. This provides the simplest example of an unstable resonance between a gravity mode, such as a Kelvin wave, and a vorticity mode. This interaction (which is not captured by the quasigeostrophic approximation) is presumably the

mechanism of the frontal instability observed by Griffiths and Linden (GAFD, 1982, 159-187) in laboratory experiments. The work has been submitted (Sakai, 1987).

J. Federiuk, working with C. Wunsch completed a Master's thesis on an inverse analysis of the Navy sponsored C-Salt Expedition data. This work is part of the on-going effort to find methods for systematically combining data sets with theoretical ideas and models.

I. Fukumori, also working with Wunsch, is continuing work on his PhD thesis directed at other data/model problems. In part 1, he inverted the data from the warm-rings program to estimate the circulation and mixing in a near-Gulf Stream ring. In part 2, he is applying the ideas to the entire North Atlantic, but with the focus on reducing the large scale data base to a set of economical empirical orthogonal functions.

Wunsch has been continuing his work on the study of data/model combined usage in time-evolving models. We have found that systematic application of methods derived from control theory presents a very general framework encompassing both classical assimilation, but sensitivity and inversion as well. The work originated in applications to transient tracers, but is now turning toward dynamical evolution models.

Two Naval Officers, K. Holderied and J. Campbell, here under the Secretary of the Navy's initiative, are analyzing two types of remote sensing data (scatterometry and Geosat altimetry respectively), for the purpose of combining these data sets with the models being developed concurrently. Both these students will receive Master's degrees.

Preparation of the tomographic instruments which will be deployed near the Gulf Stream, and provide a novel in situ estimate of vorticity there has proceeded. Construction of the prototypes has been completed by Webb Research Inc., and delivered to the Ocean Engineering Department at Woods Hole Oceanographic Institute. A change in plan was the decision to spend a full year in laboratory and in situ (i.e., in the water) testing of the instruments prior to deployment, rather than going so quickly from prototype to scientific experiment. These instruments will be deployed as part of

SYNOP in Autumn 1988 for one year in an effort collaborative with French tomographers in Brest.

Theoretical work on tomography in collaboration with Walter Munk and others continues.

Accession For	
NTIS GRA&I	<input checked="checked" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

Papers Supported (wholly or in part) on this Chair.

Federiuk, J., 1987. Determination of advection and diffusion in a thermohaline staircase region., S.M. thesis, Dept. of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology.

Haidvogel, D., J. Wilkin and R. Young, 1987. A primitive equation model for coastal applications., in preparation.

Imawaki, S. and C. Wunsch, 1987. Methods for altimetric data reduction., to be published.

Malanotte-Rizzoli, P., R. Young and D. Haidvogel, 1987. Initialization and assimilation experiments with a primitive equation model., in preparation.

W. Munk and C. Wunsch, 1987. Bias in acoustic travel time through an ocean with adiabatic range-dependence. Geophysical and Astrophysical Fluid Dynamics, 39, 1-24.

Ponte, R. M., C. Wunsch and J. R. Luyten, 1987. Apparent vertical propagation of equatorial deep jets., submitted for publication.

Sakai, S., 1987. Rossby-Kelvin instability: A new type of ageostrophic instability caused by a resonance between Rossby wave and gravity wave, submitted for publication.

Wunsch, C., 1987. Eclectic modelling of the North Atlantic, Part 2: Transient tracers and the ventilation of the eastern basin thermocline. Phil. Trans. Roy. Soc, A, in press.

Wunsch, C., 1987. Using transient tracers: the regularization problem., Tellus, in press.

Wunsch, C., 1987. Transient tracers as a problem in control theory., submitted for publication.



END  
DATE  
FILMED  
MARCH  
1988  
DTIC